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Advanced Oxidation of Contaminants of Emerging Concern: Photocatalysis and Antibiotics

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Contaminants of Emerging Concern (CECs) refers to any chemical discovered in water or in the environment that had not previously been detected, or were only present at insignificant levels. CECs is the general term covering a wide class of different types of chemical compounds, including disinfection by-products, endocrine disruptors, industrial chemicals, natural toxins, Persistent Organic Pollutants (POPs), Flame Retardants (FRs), Artificial Sweeteners (ASWs), Pesticides, Pharmaceuticals and Personal Care Products (PPCP) [1-2]. Pharmaceuticals are among the prime examples of emerging contaminants since up to 90% of oral drugs pass through the human body and end up in the environment ranging from nanogram per liter (e.g., carbamazepine) up to milligram per liter (e.g., acesulfame) concentration levels [2]. Antibiotics are the most consumed group of pharmaceuticals and their presence in the effluents of urban wastewater treatment plants is associated with Antibiotics Resistance (AR) and Antibiotic Resistance Genes (ARG) transfer [3].

Advanced Oxidation Processes (AOPs) consist a family of technologies based on the *in situ* production of Reactive Oxygen Species (ROS) with very high oxidation potential. Due to their unselective nature, different AOPs have attracted the scientific interest for their ability to completely destroy various CECs such as pharmaceuticals [4-6]. The application of Advanced Oxidation Processes (AOPs) on mitigation of the CECs from aquatic environment was overviewed. In this regard, the utilization of various AOPs including ozonation, Fenton processes, sonochemical, and TiO_2 heterogeneous photocatalysis was reviewed and some innovations (e.g., visible light heterogeneous photocatalysis, electro-Fenton) concerning the AOPs and the combined utilization of AOPs (e.g., sono-Fenton) were documented [5].

Photocatalysis which is a promising green technology using solar energy has been one of those few processes among AOPs installed at industrial scale applications. This process, can drive redox reactions under visible light (>400 nm). In heterogeneous photocatalysis, the photocatalyst is present as a solid with the reactions taking place at the interface between phases, *i.e.*, solid-liquid or solid-gas. In semiconductor photocatalysis, the primary reactions are electrochemical oxidation or reduction reactions involving hole and electron transfer from the photo-excited semiconductor [7-8]. There are common known photo-semiconductors such as ZnO, WO_3, MoO_3, ZrO_2, SnO_2,, Fe_2O_3, etc.), titanium dioxide (TiO_2, titania) is one of the most promising candidates for commercial solar applications with its photochemical stability and high oxidation power (3.2 eV vs. NHE) corresponding to photons with a wavelength of 388 nm. The absorption range of TiO_2 may be expanded into the visible light range by various dopants (metals, noble metals, non-metals) to increase electron transfer [7,9]. The electron transfer can be increased using hybrid photocatalysts [10].

Recent literature studies showed that photocatalysis enables to degrade effectively antibiotics in both heterogenous [11-14] and homogeneous reactors [15-16] as well as Antibiotic Resistance (AR) and Antibiotic Resistant Gene (ARG) transfer [17]. In those studies, the key parameters such as pH, water matrix, scavenger to affect the process efficiency are documented to improve the reactor design at full scale applications. Those studies have also focused on toxicity assessment in effluent [11-16] in parallel to obtain evironmental friendly discharges following a holistic approach.

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